

# EXPLORATIONS IN SCIENCE AND ASTRONOMY EDUCATION

Final Report  
Includes Final Reports on 3 Associated IDEA Grants

Jeffrey O. Bennett  
Center for Astrophysics and Space Astronomy  
University of Colorado

## INTRODUCTION

This document is the final report on NAGW-3667, entitled "Explorations in Astronomy and Science Education." It also includes my final reports on 3 associated IDEA grants:

1. 1993 IDEA Grant entitled, "Investigation into the Use of Science and Astronomy to Improve Pre-Calculus High School Mathematics."
2. 1994 IDEA Grant entitled, "An Astronomy and Space Science Resource Center for Teachers."
3. 1994 IDEA Grant entitled, "The View from Spaceship Earth."

## EXPLORATIONS IN ASTRONOMY AND SCIENCE EDUCATION

The purpose of this grant was to build on the experience I gained as a Visiting Senior Scientist (VSS) in the Astrophysics Division by allowing me to devote time to the development of new approaches to improving mathematical, scientific, and technological literacy in the United States. Like my work at NASA, my efforts spanned the spectrum of pre-collegiate, undergraduate, and public education. Below I summarize the accomplishments in each of the five project areas spelled out in the original proposal.

**Project Area 1:** Curriculum development efforts for *Quantitative Literacy, A New Approach to Mathematical, Scientific, and Technological Understanding*. The *Quantitative Literacy* curriculum represents a unique, *interdisciplinary* approach that emphasizes the practical uses of mathematics in our modern culture, stressing the relationships between mathematics, logic, science, and the scientific method. In addition, the course reviews basic mathematical skills and presents an introduction to some of the most important quantitative, scientific, and technological issues facing the United States today. While the curriculum is not primarily focused on astronomy, it makes use of all of the space sciences both from the standpoint of their necessity to scientific literacy and as motivational tools for teaching quantitative concepts.

### *Accomplishments:*

- I substantially refined the curriculum originally developed for the existing undergraduate course at the University of Colorado. The results of the curriculum development work are now being disseminated through my textbook, written on unfunded personal time, called *Quantitative Reasoning: Mathematics for Citizens in the 21st Century* (Addison-Wesley, 1996). I also presented on the curriculum at several national and region meetings of mathematics instructors, including the annual meetings of the International Conference on Technology in Collegiate Mathematics and the 1994 meeting of the California Community College Mathematics Council South.

- In conjunction with three graduate students (Hal Huntsman, Dave Theobald, and John Supra), I completed development of a computer lab to accompany the Quantitative Literacy curriculum. The lab was successfully tested at CU and independently at Boston University. The lab will require further effort for widespread dissemination, an effort currently on hold as I focus attention on other projects.
- I worked with two local high school teachers to modify the Quantitative Literacy curriculum for the high school level. This new course was taught in place of "traditional" pre-calculus for high school seniors at Centaurus High in Lafayette, CO. It was designed to encourage students to move on to calculus in college, and targeted those students who might not otherwise do so. The course was quite successful, but funding for the teachers came from my 1993 IDEA grant. Without subsequent funding, the course has not been taught again.
- I worked with a graduate student (Debbie Segal) on a careful assessment of the quantitative literacy program. The results were used as feedback in the curriculum development effort.
- I worked with the CU Division of Continuing Education to make the quantitative literacy program available to students in the Continuing Education program. The course is now a regular offering in that program.

**Project Area 2: Astronomy for elementary and middle school teachers.**

*Accomplishments:*

- I worked with two faculty members — Fran Bagenal of the Astrophysics department and Nancy Songer from the School of Education — to create a detailed plan for a special section of college-level introductory astronomy for elementary and secondary teachers. We have not yet implemented the plan, but hope to do so in the near future.
- I created a new course bringing scientists and pre-service teachers together to discuss the relevance of astronomy to public school teaching. The course, called "Astronomy and the Public Schools," was taught in Spring 1996 as an offering of the School of Education.

**Project Area 3: Scale Model Solar Systems.**

*Accomplishments:*

- Along with Tom Ayres and Jodi Schoemer, we completed a repair and redesign of the Colorado Scale Model Solar System.
- Along with Jeff Goldstein and Jodi Schoemer of the National Air and Space Museum (NASM), we have gained approval to build a similar model solar system at NASM in Washington, DC. Construction is expected in 1997. We also are working to build similar models at 20 or more additional institutions around the country.

**Project Area 4: Public outreach in science and astronomy, with emphasis on the connection between space science research and general educational goals.**

*Accomplishments:*

- I started an educational steering group made up of faculty members at the University. The group met regularly for many months, and members continue to work on project ideas spawned from those discussions.
- We created a public display of NASA's Perspectives From Space poster set at the University of Colorado.
- I helped to organize exhibits and volunteers for a space science pavilion at Black Expo 96, a convention in Denver that drew some 30,000 visitors.

## **Project Area 5: Additional educational research efforts.**

### ***Accomplishments:***

- After leaving NASA I continued my work with the NASA Education Division which led to the publication of a new poster called *NASA Superstars of Science* (WED-111).
- I worked with a graduate student (Stephanie Gates) in biology on a research project aimed at increasing the quantitative component of high school biology classes. The purpose of this is to help students interested in biology or medicine overcome any fears of mathematics they might harbor.
- I continued my work in exploring connections between space science research and education, resulting in two published papers.
- I served as an advisor to NASA on a number of educational issues. I participated in a NASA workshop on the IDEA grants. I was an original member of the Space Telescope Advisory Committee on Education (STACE). I consulted on educational opportunities with the SOFIA mission, which will build upon the FOSTER project that I helped start while at NASA.
- I spent significant time working with Dick McCray, Katy Garmany, and Phil DiStefano on a plan to make public school teaching a viable career path for graduate students in astronomy. Our ideas have been well-received, but the work is on hold due to lack of funding.
- I served as a volunteer member of the local strategic planning board for the Colorado State Systemic Initiative, and NSF-funded project.
- I was the invited public speaker for the American Astronomical Society, High Energy Astrophysics Division Annual Meeting in November 1994. I developed and presented a talk called, "The Invisible Cosmic Cauldron."

### **IDEA GRANT 1: INVESTIGATION INTO THE USE OF SCIENCE AND ASTRONOMY TO IMPROVE PRE-CALCULUS HIGH SCHOOL MATHEMATICS**

This IDEA grant in 1993 funded the buy-out time for the high school teachers involved in development of a high school version of the quantitative literacy course, discussed above under Project Area 1. The project was successful.

### **IDEA GRANT 2: AN ASTRONOMY AND SPACE SCIENCE RESOURCE CENTER FOR TEACHERS**

I was a co-I on this 1994 IDEA grant used to develop a resource center located at the Sommers-Bausch Observatory at CU. After helping to get the center off the ground, I turned over full control of the project to PI, Katy Garmany.

### **IDEA GRANT 3: THE VIEW FROM SPACESHIP EARTH**

This 1994 IDEA grant was intended to develop a new series of Planetarium shows focused on teaching the basics of the night sky, including constellations. I developed and produced the series for the high school students enrolled in my Young Scholars Program astronomy course. I had hoped to go further, developing the shows for the public as well. However, the IDEA grant alone did not provide sufficient funding for this effort, so I had hoped to continue the effort as part of the work on other educational grants. Unfortunately, I have not yet received any other grants, so the expansion of this effort is on hold.

## GRANT-RELATED PUBLICATIONS

- Bennett, J.O. 1994, "Mission to the Universe," *Astrophysics and Space Science.*, 214, 225–235.
- Bennett, J.O. and Morrow, C.A. 1994, "NASA's Initiative to Develop Education Through Astronomy," *Astrophysics and Space Science.*, 214, 237–252.
- Bennett, J.O., Supra, J.R., Morrow, C.A., Huntsman, S.H., and Theobald, D.M., 1993, "Quantitative Literacy: An Alternative Course in College Mathematics," *Proceedings of the 6th Annual International Conference on Technology in Collegiate Mathematics*, Addison-Wesley, Boston, MA.
- Bennett, J.O., Nurriden, A., LeSane, G., and Gaskins, M., 1993, *NASA Superstars of Science*, an educational poster about African-American scientists, NASA Publication WED-111.
- Bennett, J.O., Briggs, W.L., and Morrow, C.A. 1996, *Quantitative Reasoning: Mathematics for Citizens in the 21st Century, Preliminary Edition*, Addison-Wesley Publishing Company, Boston, MA. [Produced on personal time, but using ideas developed as part of the grant.]